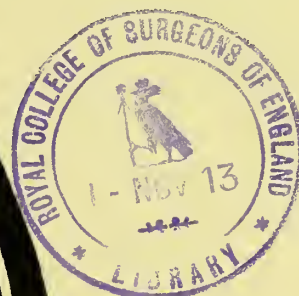


THE  
APPARATUSES OF THE SYSTEM  
**„DRÆGER”**  
IN THE INTERNATIONAL  
RESCUE-SERVICE

13.



Draeger



DEDICATED BY THE  
**DRÆGERWERK · LUBECK**  
GERMANY



All the important features of the Draeger apparatus are protected by numerous Patents in all civilised countries and many Patent Applications are pending in respect ... of the newest patterns and details. ...

# Draeger-Hefte



## Periodische Mitteilungen des Draegerwerkes Lübeck

September 1913.

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Number 14a.

Matters: „Draeger“ Life Saving Apparatus. — The „Draeger“ Oxygen Rescue Apparatus. Illustrated. — The „Draeger“ Potash Cartridge. Illustrated. — „Draeger“ Reviving Apparatus. Illustrated. — The „Draeger“ Diving Rescuer for Submarines. Illustrated. — The Self-contained „Draeger“ Diving Apparatus. Illustrated. — „Draeger“ Apparatus for Aeronautics. Illustrated. — Autogenous Cutting in the Rescue Service. Illustrated. — On the development of the Draegerwerk. Illustrated.

### »Draeger« Life Saving Apparatus.

Resumé.

When we recognised 20 years ago the importance of compressed oxygen would play in all branches of rescue work, if the construction of Apparatus could reach an unprecedented safety in action, we and our collaborators worked incessantly, spurred on by the highest idealism, to attain this end. In this never to be forgotten period of development of the Draegerwerk; as we ourselves had still to fight with materialism and with cares and inventor-disappointments, it was then that the ideas were born which to-day have become the general property of international rescue work, i. e. Help to centralise rescue work by the construction of **uniform** rescue equipment; utilisation of the motive power contained in compressed Oxygen for the air revivification in self-contained Rescue Apparatus; complete absorption of Carbon dioxide, by means of regenerating devices in Cartridge form, and uniting rescue and reviving by the creation of Oxygen Reviving Apparatus.

When we to-day look back to the years of development, we see many things which were bitter and sorrowful enough. We had to experience that the ideal joy in creating, and the conviction of the value of ones own work alone is not sufficient in order to penetrate to the public, which only too often is lead by elusive successes.\* Our belief in the mission of Oxygen was not the belief of others. There remained nothing for us to do

but to work on indefatigably in order to close the gaps which still showed themselves in self-contained rescue apparatus. The profit of this experience has not been ours alone, but others joined in, and to-day it has become common property.

Bernh. Draeger's investigations regarding the requirements of a Rescue Apparatus useful for work, with which the 1st International Rescue Congress of 1908 at Frankfurt a. Main stll concerned itself, established the irrefutable fact that a Rescue Apparatus, capable of the heaviest work, should supply 50 litres of pure air per minute and should be so constructed as to supply 2 litres of Oxygen per minute. The Apparatus must also absorb 94 litres of Carbon-dioxide which the worker exhales during 2 hours. These values were up to then — 1904 — unknown to the physiological science. The correction of the older perception which had become an established principle, was received with resistance, as may well be perceived. To-day it has been accepted

\* Characteristic for the state of affairs of that period are the treatises „Beiträge zur Chemie und Mechanik von Rettungsapparaten“ (Zeitschrift f. d. Berg-, Hütten- und Salinenwesen im Preuss. Staate, Jahrg. 1905) and „Chemie und Technik an Sauerstoff-Atmungs-Apparaten“ (Zeitschrift für Chemische Apparatekunde, Jahrg. 1905, Seiten 68/73).



as correct by the users of 7000 sets of „Draeger“ Rescue Apparatus, which are spread over the whole world. These values have also been fundamental for the construction of the „Draeger“ Diving Apparatus. To-day the battle for perception and acknowledgement lies in silence behind us. The „Draeger“ Work goes free through the world, carried by many brave men. We, in 14 years of our work in the rescue service, have spoken very little of the same. The Manufacture of Rescue Apparatus fights against the drawbacks of our culture, against the dangers of technical development, — both matters of social life — which can never be neglected. It appeared at one time as if the manufacture which had arisen from the drawbacks of life was reproached for its very existence. It requires no explanation to understand, how strong the idealism of the constructor must be, not to resign against this appearance. Nowadays, however, the activity of the rescue engineer is no object for controversy. It has been beneficial beyond all expectations in saving human lives and property. The weapons which issued from the „Draeger“ workshops have proved their efficiency and value manifold, and only then, as the good results in serious use of the „Draeger“ Apparatus could no longer be doubted or belittled, we decided, pressed by the rescue world, to publish our work and its effect. We were told that this was our duty. On these grounds we publish this book for the Members of the Second Life Saving Congress in Vienna.

But we are not free from the duty of thanks to others. We have many times repeated that the exchange of honest thoughts and experiences between leaders of rescue corps, rescuers, etc., and the constructor has created many improvements, which are embodied in the latest type of Rescue Apparatus. With high admiration and deep gratitude we have watched the deeds of the rescue heroes at Courrières, Reden, Forbach, Königshütte, Hamstead, Maypole, Cherry, Rykow, in the Sydney and Albion Mines, at Wharnccliffe, and quite recently at the North Lyell Mine. We followed with satisfaction how, with each victory over the elements, the belt of stationary and moveable rescue stations grows narrower round the earth, and how the Rescue Apparatus was not only used in a negative way for saving property, but how it was also used in a positive manner as a working instrument. Larger and larger grew the army of rescue men, patronised by Emperors and Kings. The development grows incessantly, and we could notice by the extension of our work which has been

forced upon us, how systematic is the training in the „Draeger“ Apparatus.

Similar, only quicker, developed the public organisation of Reviving Work, as after the first International Life Saving Congress, the Oxygen Reviving Machine the „Pulmotor“ — then still sealed — was handed over to rescue practice. Over 2000 „Pulmotors“ are at present in use, and there is hardly a day on which, by the application of this Machine, a life is not saved. If anywhere, it is proved here that the mission of the Oxygen is not a vague supposition. Long before the appearance of the „Pulmotor“, the „Draeger“ Oxygen Trunk of which over 3000 sets are in use in the international rescue service had drawn attention to the beneficial effect of Oxygen inhalation given on a physiological basis.

It appeared that only by the combined work of Rescue- and Reviving Apparatus, an increase of rescue successes would be possible. This conviction has proved in practice to be correct. To-day there are very few rescue stations who would forego a union of salvage and reviving.

Soon, after a temporary repose in the construction of Rescue Apparatus had been reached, we turned our attention to the Diving Apparatus. With the thought to make the diver independent of the air supply from outside and therefore independent of dangerous pipelines, by the creation of Self-contained Oxygen Diving Apparatus, we conceived the idea to construct rescue equipment for submarines, which enabled the crew of a damaged submarine to escape from the wreck by rising upwards from up to 60 meters depth.

Both Apparatus — the Self-contained Diving Apparatus and the „Draeger“ Diving-Rescuer — the equipment of the German and other submarines — which like the Rescue Apparatus, are intended for rescue and work. The Appliances are since 16 months in the rescue service — the Diving-Rescuer also as a special type as rescue appliance for swimming baths and hydroplanes.

There remains to be mentioned in this article our relations to the rescue service of air navigation, by the construction of Respirators for high-altitude flying, and to remind that the „Draeger“ Autogenous Cutting Apparatus, sold by Griesheim-Elektron, are used for the first-aid service of railways.

Of all these the reader will find details on subsequent pages.  
W. H.





Fig. 1. Draeger-Oxygen-Breathing-Apparatus. Pattern 1913 of one and two Hours Working Capacity;  
for Mines, Fire-Brigades, Gasworks, for Well Sinking, Chemical Factories,  
Slaughter-houses and Refrigerators and for the Navy.



# The »Draeger« Oxygen Rescue Apparatus

by J. W. Haase-Lpe. With 11 Illustrations and 1 Diagram.

The „Draeger“ Rescue Apparatus for use in irrespirable atmosphere may be used with Helmet or Mouth-piece. It is self-contained, i. e., independent of the outside air. The Apparatus purifies continuously the expired air. It renews constantly the used-up Oxygen and makes the CO<sub>2</sub> produced by the breather harmless. The dress is so compact as not to hinder work in narrow spaces.

The modus operandi of the Apparatus is as follows: The exhaled air escapes through the exhalation pipe s<sup>1</sup> and through the exhalation valve v<sup>1</sup> into the exhalation bag b<sup>1</sup>, from whence it is drawn by the injector nozzle d. It is then drawn through the Potash Cartridge p, here the air is purified and warmed; and flows through the cooler l to the injector d, where it is revived by oxygen at the rate of 2 litres a minute. The air mixture, now again suitable for breathing, flows through the second pipe z<sup>2</sup> into the inhalation bag b<sup>2</sup> and from here through the inhalation pipe s<sup>2</sup> and the inhalation valve v<sup>2</sup> into the mouth of the wearer to be re-inhaled. Then the circulation is repeated anew. (See diagram.)

If the reader knows physiology, he will recognize at once, that the Apparatus is a technical reconstruction of the physiological conditions prevailing on our earth. Heindr. Draeger says in one place of his biography: „The modern inventor, if he wishes to create something perfect, must understand in a poetical manner the ways of expression of nature, in order to translate the same into technic, as it is impossible to copy or simply translate nature. Nature also creates more universal. Man must specialise. He must adapt his tools and arrangements for one purpose only. By means of this concentration he is enabled to surpass manifold the working of the natural organs with his machines.“

The Rescue Apparatus makes the man, equipped with the same, to a higher organised being; because a new circulation-organ working together with his other internal organs is added, an air-circulation organ, similar to a blood-circulation organ consisting of heart and arteries.“

According to Bernh. Draeger's investigations, which have since been recognised as the foundation of breathing apparatus, a rescue apparatus should circulate 50 litres of pure air per minute. It should also absorb during 2 hours of hard work in the apparatus about 94 litres of carbon dioxide. The „Draeger“ Rescue Apparatus fulfils these conditions. The two separate bags, one for inhalation and one for exhalation, prevent entirely that the expired air is re-inhaled again. During the two hours work, for which the apparatus is constructed, 7200 litres of air are moved through the circulation circuit; it supplies during the same time 240 litres of oxygen and absorbs 100 litres of carbon dioxide. The Potash Cartridge of the 1910/11 pattern

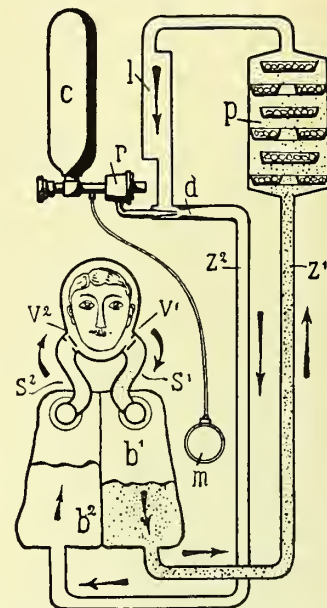


Diagram of the Modus operandi of the Draeger-Rescue-Apparatus.

or two Potash Cartridges of the 1904/09 pattern allow work up to 36 000 meter-kilograms to be performed. Untrained men perform less, while trained men do more. As much as 56 000 M. Kg have even been reached. The Apparatus is capable of being used day and night underground or aboveground for fire brigade-work, on account of the simple and quick way in which the cartridges can be exchanged.

Heindr. Draeger summarises the singular construction of the Rescue Apparatus in the following sentences: „While the air circulates through the Apparatus, being revived by oxygen and the exhaled carbondioxide is absorbed in the Cartridge, the wearer breathes, according to the output of work, quietly or wildly, from the inhalation bag pure air and exhales into the exhalation bag the vitiated air. He knows nothing of the wonderful process taking place in his apparatus; he breathes as in pure air. He cares nothing, like our mother earth, that round him lurk dangers and death. Both form for them selves a world of life of their own. But from the aesthetic point of view man stands higher. The Earth is an embodied Egoist. Man on the other hand stands in such moments in the service of his unfortunate brethren, in the service of humanity, he cares only for others. It is the same to him, whether he goes down into the bowels of the earth where fire damp prevails, or whether he goes into a pipe filled with coal gas, into sulphur fumes or to the bottom of the sea. He breathes pure air.“

The number of „Draeger“ Rescue Apparatus in use has surpassed 7000 sets. They are to be found in all coal producing countries of the earth. They may be found in Germany, France, England, Belgium, Holland, Austria, Hungary, Switzerland, Roumania, Italy, Spain, Luxemburg, Denmark, Sweden, Norway, Finland, Russia, China, Japan, Australia, United States, South America, Canada, Mexico, South Africa, West Indies, India etc. etc. The Rescue Apparatus is being used as Smoke Helmet — one hour type — by about 150 Fire Brigades. By reason of the daily increasing demand for Potash Cartridges it may be deduced that the use of this Apparatus is growing steadily.



Fig. 2. Old phantastical type of a gas-diving equipment for mouth-breathing.



Fig. 3.



Fig. 4.

The Interior of the Central Rescue Station of  
TAMINES, Belgium.



In order to judge of the utility of the Rescue Apparatus, the following facts may be of interest:

During the last 5 years 168 lives were saved by means of the „Draeger“ Rescue Apparatus.

1. Reden (Saarbrücken) Germany, 1907 . . . . . 23 men
2. Forbach (Klein-Rosseln) Germany, 1907 . . . . . 13 „
3. Saar und Mosel Colliery, Merlbach, Germany, 1907 . . . . . 8 „
4. Königshütte = pit fire, Germany, 1908 . . . . . 14 „
5. Sektion IV (Halle) Germany, 1908/12 . . . . . 10 „
6. Cherry Mines, Illinois, 1909 . . . . . 30 „
7. Fürstensteiner Pit, Idaschacht, Germany, 1909 . . . . . 1 „
8. Aller-Nordstern, Grosshäuslingen, Germany, 1911 . . . . . 5 „
9. Markham Sinkings, Hollybush, Mon. England, 1912 . . . . . 1 „
10. Fire Brigade, San Francisco, U. S. A., 1912 . . . . . 2 „
11. Pit „Italianka“ Makeewka, Russia, 1912 . . . . . 6 „
12. Salt Mine, Neustassfurt, Germany, 1912 . . . . . 2 „
13. North Lyell, Australia, 1912 . . . . . 50 „
14. Birmingham Fire Brigade, England, 1913 . . . . . 2 „
15. Cadeby Mine, Rotherham, England, 1913 . . . . . 1 „

168 men

The number of rescued is in reality larger, as it is not always possible to ascertain with what success the Apparatus has been used. The only means by which authentic figures can be ascertained is a centralisation of news about the result of rescue work. The information of the successes of work with rescue apparatus given here, is, however, sufficient, in order to contradict statements so often repeated that breathing apparatus are of little value for the saving of lives. A most important fact should here be specially noted. The success with rescue

apparatus started to increase from that moment when the rescued were treated with oxygen — up to 1908 by inhalation of Oxygen and later by artificial respiration with the „Pulmotor“ combined with Oxygen inhalation.

The high economic value of the breathing apparatus has been proved in hundreds of cases where very often work had to be done under most desperate conditions, not only in fire brigade work, in gas factories, chemical works, cold storage works, and the Navy, but specially in mines. In the annual report 1912 of the Institute of Mining Interest in the Mining District of Dortmund (Germany), where several hundred sets of „Draeger“ Rescue Apparatus are installed, is stated: „The frequent and successful use of Rescue Apparatus shows their economic advantages clearly to mines.“ The Institute mentioned should undoubtedly be competent to judge.

Typical of the energetic and successful development of the German Mining Rescue Organisation is the **District of Halle, Section IV**. A Review of the last five years shows the following official statistics:

There were installed in the year . . . . .	1908	1909	1910	1911	1912
<b>Draeger Apparatus . . .</b>	<b>134</b>	<b>164</b>	<b>182</b>	<b>220</b>	<b>272</b>
There were available in the year . . . . .	1908	1909	1910	1911	1912
<b>Rescue Men . . . . .</b>	<b>280</b>	<b>1340</b>	<b>1516</b>	<b>1770</b>	<b>2010</b>
There were held in the year	1908	1909	1910	1911	1912
<b>Practices . . . . .</b>	<b>195</b>	<b>597</b>	<b>958</b>	<b>970</b>	<b>1607</b>
Cases of successful use of the Draeger in the year	1908	1909	1910	1911	1912
<b>for rescue . . . . .</b>	—	<b>1</b>	<b>2</b>	—	<b>2</b>
<b>for recovery work . . .</b>	<b>3</b>	<b>10</b>	<b>17</b>	<b>13</b>	<b>13</b>

In the German, Austria-Hungarian and Swiss Rescue Service for mines, fire brigades, industrial works and the Navy, were on 1st Sept. 1913 approximately 3500 „Draeger“ Rescue Apparatus. For every Apparatus three men are trained on an average, so that at present there is at least an army of 10 500 rescue men ready to use them. In mining, the average number of trained rescuers is as a rule at least 50% higher. If the average, relative to the above mentioned Countries, is taken for the entire number of „Draeger“ Apparatus spread over the world, there should be at least 21 000 trained „Draeger“ Rescuers. Also here is the actual proportion more favourable. Great exertions were made during the last 5 years to keep this army ready for action, as has been shown on occasions of large catastrophes. Everywhere the rescue stations and rescue equipment are enlarged in a systematic way, and quick means of transport — rescue motor cars — are kept in readiness, as is the case in English and some of the American Rescue Stations. In the United States, where over 1500 „Draeger“ Apparatus are in use, rescue stations on wheels in special Pulman Cars are the centre of a wide spread and splendidly organised rescue scheme. On similar lines the Fire Brigade rescue service is also being developed.

It is of the greatest importance that rescue appliances should be kept in perfect order and treated with the utmost care in order to derive the desired benefit when in action. Of equal importance is the untiring training of the rescuers. No



Fig. 5. Rescuing the victims of the North Lyell Mine. October 1912. — „The Leader“ No. 2964.





Fig. 6. One of the 7 Rescue-Cars of the U. S. Bureau of Mines equipped with Draeger Apparatus.



Fig. 7. Rescue-Car of the Nova Scotia Steel and Coal Company (Canada) equipped with Draeger Rescue Apparatus and Pulmotor.

half or insufficiently trained men should be allowed under any circumstances to wear apparatus in actual cases. We have on every suitable occasion emphasised with the utmost clearness that when penetrating into the workings, from the cage up to the point where for certain the air is pure, rescuers should never shut off the apparatus and take their mouth pieces out of the mouth. With the inverse process — advancing with open helmet-lid and closing it after detecting noxious gases — the danger of self-poisoning is lurking in wait — as in following this course the circulation air of the apparatus is saturated with gases of the after-damp which often will exert their deadly effects only much later. Captain of teams should therefore exert all their authority to see that the men pay attention to these perils. A few accidents have happened during the last years, which, however, stand in no proportion to the number of apparatus in use, but these are all to be attributed to improper use and application. We think with sorrow of the victims who have given their lives for a new movement in the service of love for their comrades.

The courage which trained rescuers are able to show is clearly established in the following articles:

„In No. 15 dated 23rd April 1913 of the Journal „Gornosawodskoje Djelo“ published by the Institution of Mine Owners of South Russia, we read on page 7136 the following: On the 1st April at 11 o'clock a call was made at the Gruschewskaja Rescue Station to send rescue men to the Pit „Gebr. Arasew Owanessews Erben“, where a fire had broken out. Rescuers, equipped with „Draeger“ Apparatus, descended at once the shaft 75 meters deep. It was ascertained that the lower frame work in the shaft was alight and that the bank was completely covered with debris, which hindered the free movement of the cages. All these obstacles were removed by the „Draeger“ men, which enabled the cages to be lowered. For 3 days the men, together with the manager, worked with the Apparatus and extinguished the fire, made good the ventilation, and did other necessary work.“

The Pittsburgh Coal Co. reports under 1st May 1913: „On the Morning of April 3rd, during the high water, Green River broke through into an old shaft which was connected through into our Spottsville Mine.

After working for several hours in trying to stop the flow of water by choking the shaft mouth we got into communication with Mr. Powell of the Government Mine Rescue Station at Evansville and arranged for him to come up by boat to the mine in order to effect an entrance at the main shaft by use of the oxygen helmets.

Immediately upon the water breaking in an effort was made to get into the workings from the main shaft but the black damp was so rank that even a carbide light was put out within fifteen feet from the surface. It was being forced out of the old workings by the inrush of water.

The fan is motor driven and the water had crossed the road back in the workings and put the line (which was underground) out of commission. We tried to maintain circulation by turning the fan by hand but could not do so, the water evidently being to the roof between the fan and main shafts. This left the oxygen helmets as the only means by which we could have any hope of effecting an entrance and getting the machinery out.

On account of the floods the railways were all out of commission and the river was so rough that Mr. Powell had some difficulty in getting a boat to come out. This emphasizes the necessity of having helmets at the mine to supplement those at the nearest rescue station. Though we are situated within twenty miles of the Evansville station by rail the need for the apparatus arose just at the time when this means of communication was under water.

Mr. Powell and three men entered the mine immediately on his arrival, after the water had been running into the mine for twenty seven hours. Within two hours they had recovered four mining machines and a six ton motor and hoisted them to the surface, all the machinery that was in the mine. The water followed the rescuers back to the main shaft and within a few hours there was fifty feet there.

We cannot speak too highly of the efficiency of the Draeger apparatus. It enabled us to recover several thousand dollars worth of machinery which could not have been got in any other way.“

Similar heroism of German, English, Austrian, French and Australian rescuers could be quoted. See Draeger Bulletin No. 14 (German Edition).



Fig. 8. Mine Rescue Station, Springfield, Benton and Lasalle, Illinois.





Fig. 9. Rescue men with Draeger-Apparatus, entering a Gallery after a Dust Explosion.  
National Mine Safety Demonstration. Pittsburgh, October 1911.



Fig. 10. Rescue Brigade equipped with Draeger-Apparatus at the Park of Windsor-Castle  
before the Arrival of the King. 22nd June, 1912.



# The »Draeger« Potash Cartridge

by Engineer Otto Block.  
With 2 Illustrations and 1 Diagram.

Draeger considers his Potash Cartridge as a physiological counter-piece of the lungs, which are provided with a large surface for absorbing the Oxygen. In order to provide also for the absorption of the Carbon-dioxide and water-vapours, a large surface in the Potash Cartridge — 20 flat metal trays with layers of Caustic Potash and Caustic Soda in granular form — have been provided inside the Cartridge. In the pattern 1912 of the Potash Cartridge, there are in each tray one circular opening and four semi-circular openings in the outside rim, which are from tray to tray so arranged that several zig-zag air ways through the Cartridge are formed; they guide the air current over each tray and over each grain without hindering in any way the free circulation. (Compare diagram.)

Developed by experiments through many years, proved through hundreds of thousands of applications, the „Draeger“ Absorbing Cartridge is an important member of the different „Draeger“ Apparatus. Size and weight of the Cartridge, compared with the length of time they work, are exceedingly small. The quantity of absorbing grains has been so measured out that there is an ample margin, even if the Cartridge is abnormally strained, to suffice for the stated time of work prescribed for the different types of Rescue Apparatus. It will therefore be seen that the capacity of the Cartridge is sufficient for the most strenuous efforts, but is far surpassed if only light work is being done.

The finding of a safe method of compounding the absorbing material into the form of a Cartridge has been of the greatest value for the working capacity of the rescuers. The Potash Cartridge is stored at Rescue Stations in larger quantities **without the same losing their regenerative properties**. Their transport and their treatment requires no special precautions. In this way the rescue ammunition became of unprecedented reliability, especially as it is possible to exchange in a second the used-up Cartridges for fresh ones.

On account of the weight of the Cartridge increasing in proportion with the output of work, a new method is given for determining the amount of work done with the Apparatus. The longdisputed „Draeger“ Thesis: „The hourly Carbon-dioxide production of a person and the output of work stand in proportion to each other“ — has, since it was put up in 1904, been proved to be correct by the thousands of practices

done in training stations. The regular tests of material and Cartridges in the Draegerwerk have elucidated the fact that 1000 meter-kilogrammes work is equal to a Carbon Dioxide production of from 5 to 6 grammes = 2,5 litres. With the Cartridge, which shows after work an increase of 270 grammes in weight, about 45 000 meter kilogrammes of work has been done. The values vary a little according to the corporal disposition of the workman; they correspond, however, in the average with the standard given.

The beneficial activity of the „Draeger“ Potash Cartridge is shown by the practical results obtained with the „Draeger“ Rescue Apparatus. The Cartridge is used as the principle feature in all types of „Draeger“ Rescue Apparatus and in the Self contained Diving Appliances. They are the chief constituent of the air-purifying installations for submarines. Alone, or with a short breathing tube (figures 11 and 12), they serve as rescue instruments apart from the Escape Diving Rescue Apparatus for the entombed crew of a damaged submarine. 27 men of the German Submarine U 3, sunk in January 1911, owe their lives to these Breathing Cartridges. The exhalation air is drawn through the Cartridge, and by this means an excess of Carbon dioxide in the surrounding air is being prevented.

Very often we have been asked why is it that the potash cartridge is made round and not flat.

The „Draeger“ Potash Cartridge may be manufactured in any shape, circular, oval, and flat. The Draegerwerk is permitted to use its patents on cartridges for all forms and sizes, is therefore not restricted at all or in any way as regards the construction of the cartridge.

The essential task of the potash cartridge is the rational absorption of the expired Carbon Dioxide and therefore one should not be influenced to choose a shape that must unfavorably influence this essential task. The Draegerwerk has up to this time preferred the circular or oval cartridge because in a circular or oval recipient the trays carrying the layers of chemicals will tighten better to the rim than in a recipient which is provided with long and nearly flat walls, the tightness of which may be impaired by the least external influences. The air has to pass through the cartridge in a zigzag way; the direct way — along the sides of the walls — must therefore be intercepted. Serving for air cleaning plants in submarine boats the round cartridge (circular or oval) is the most handy one and may easily be stored in larger quantities; for the use of the „Diving Rescuer“, a round form of the cartridge (circular or oval) has always the smallest surface in proportion to its contents, to prevent the prejudicial cooling down in the water; and serving for single respiration the round (circular or oval) cartridge which conveniently may be held by one hand, has no disadvantages.

Up to the 1st Sept. 1913, about 500,000 „Draeger“ Potash Cartridges have been sold.



Longitudinal Section and Modus Operandi of the Cartridge Pattern 1912.



Fig. 11.



Fig. 12.



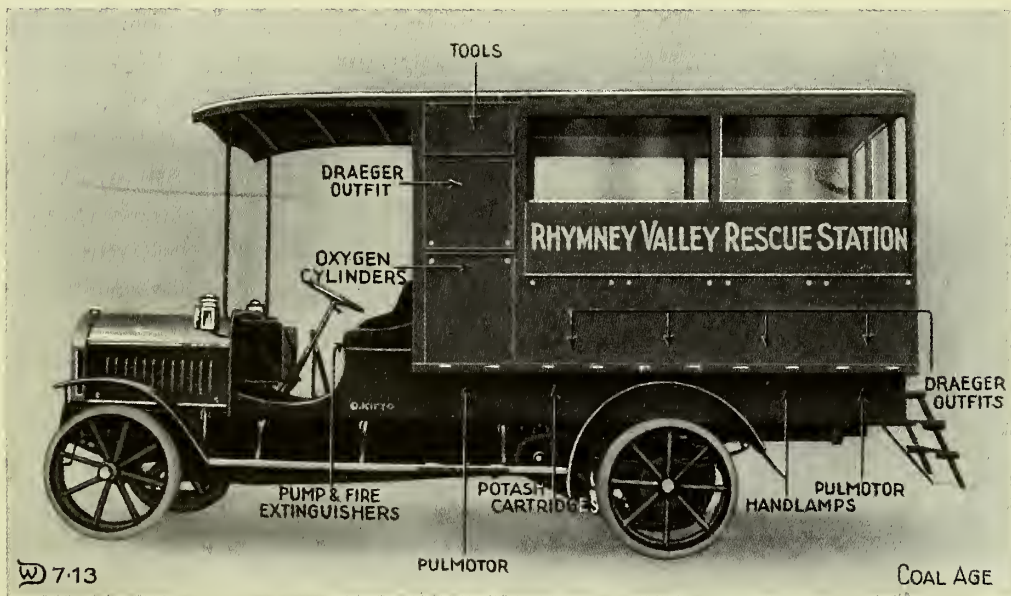


Fig. 13. Rescue Motorcar of the Rhymney Valley Rescue Station (Wales).  
Showing the Disposition of the Equipment.



Fig. 14. Municipal Fire Brigade equipped with Draeger Rescue Apparatus.



# »Draeger« Reviving Apparatus

by Engineer **Hans Schroeder**. With 2 Illustrations and 1 Diagram.

## 1. The „Pulmotor“.

The Oxygen Reviving Machine „Pulmotor“ differs from all other Apparatus intended for reviving work, insofar as it not only employs the Oxygen as a reviving agent, but also as a motive power for automatic artificial respiration. The tiring manual work is unnecessary with this Machine.

The use of the Apparatus is so simple that every layman is able to learn its application.

In the box of the „Pulmotor“ are housed 2 independent Apparatus — an Oxygen Inhalation Apparatus on the lid, and the Apparatus for automatic artificial respiration in the interior. The capacity of the Oxygen Cylinder „c“ — common to both Apparatus — is 300 litres. The Apparatus for artificial respiration works uninterruptedly für 40 minutes. For longer action (rescue has been effected after 6 hours activity) provision is made for connecting a larger Oxygen Cylinder to the outside of the „Pulmotor“.

The action of the „Pulmotor“ commences at once after the Valve „v“ on the Cylinder is opened. The Oxygen flows through the pressure reducing valve „d“ to the Injector „s“. This Injector draws in a larger quantity of outside air, and blows this air — saturated with Oxygen — at a pressure of 20 centimeters water gauge through the Inhalation Pipe „e“ into the lungs. As soon as the lungs are inflated the bellows „b“ expand and effect the automatic reversal of the Valve to suction. The lungs are emptied under a vacuum of 25 centimeters, the contaminated air containing carbon dioxide escaping through the Exhalation Pipe „a“ into the air Chamber „l“, and from there into the outside air. (Compare diagram.)

The patient is not fed with pure oxygen — and this is one

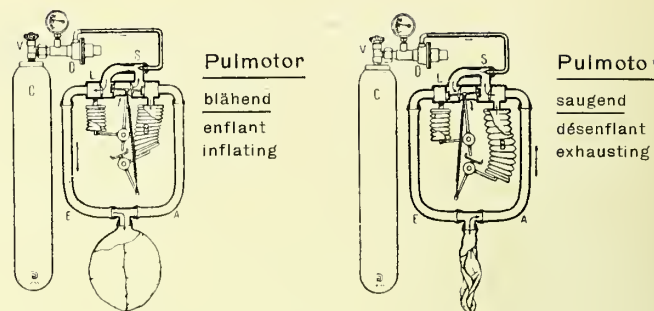


Diagram of the Modus Operandi of the „Pulmotor“.

of the most notable points of the „Pulmotor“ — but with air rich in Oxygen. Residual air cannot re-enter the lungs.

The Breathing Pipes lead into a tightly fitting Face Mask. The breathing rhythm of the Apparatus adapts itself automatically to the size of the lungs. The pressure set up in the lungs or the vacuum produced, respectively, is independent of the capacity of the lungs. The difference between pressure and vacuum can never have any harmful effect on the tissues of the lungs.

The preliminaries to be executed before the Apparatus is used are minutely described in the Instructions for handling the Apparatus, and are contained with every set. These instructions are based partly on entirely new physiological observations and can easily be executed by a layman. They consist specially in keeping the air way clear and of closing the gullet.

The „Pulmotor“ was handed over to rescue work in October 1908. Nearly 3000 sets of Apparatus are to-day in use throughout the world.

By its use 227 lives have been saved during the last 19 months.

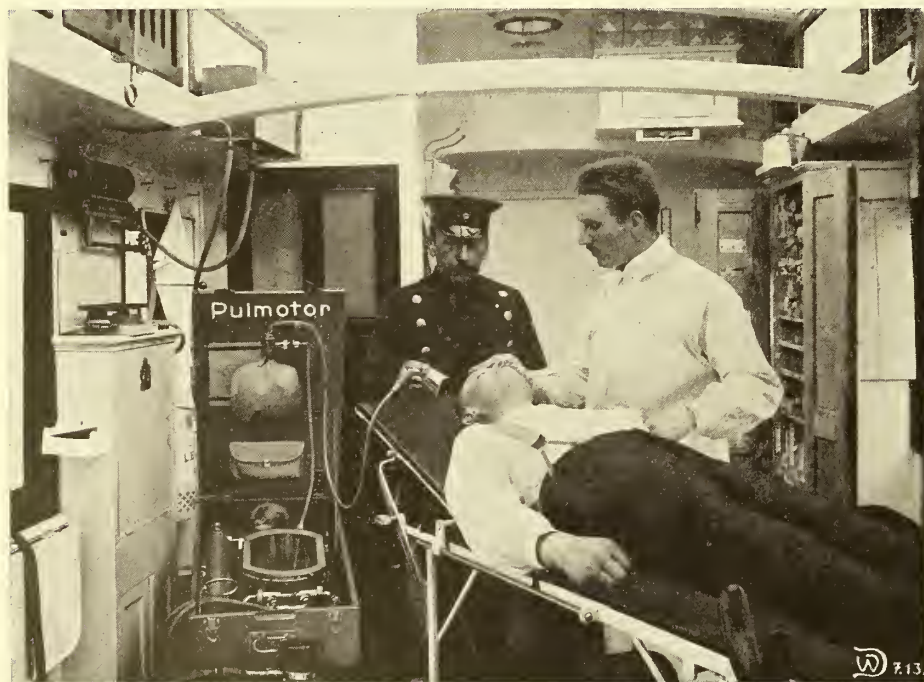


Fig. 15. „Pulmotor“ in a Railway First Aid Carriage.

The „Pulmotor“ has been applied for the following cases: **asphyxiation** by hanging and drowning; **poisoning** by carbon monoxide, coal gas, smoke, furnace-gas, medicine, aniline, morphia, chloroform, ether and contaminated food; **unconsciousness** produced by electric shock, **complications** by typhus, appendicitis; and **accidents** under narcosis. A type of this Apparatus — the „Baby Pulmotor“ has been successfully used in reviving newborn babies.

### The „Pulmotor“-Organisation.

The rapid progress of the „Pulmotor“ is without example. In the first instance it was taken up by the large Fire Brigades in middle Europe, who recognised the value of the Apparatus in being at any time ready for use and creating a valuable medium for rescue work. The foundation was laid by the application of the Oxygen Trunk. Fire Brigades of Berlin, Neu-





Fig. 16. „Pulmotor“ in Action.

köln, Hamburg, Königsberg, Bremen, Mülhausen, Stettin, Erfurt, large Fire Brigades in England, Sweden etc. have used the „Pulmotor“ with exceptionally good results. The „Pulmotor“ was then adopted by the Red Cross Rescue Corps, and also these had very soon the pleasure to look back on a large number of rescues effected. Before, however, this Reviving Apparatus was introduced to the public rescue service, it was already known to ambulance and rescue brigades in mines and furnaces, who used the Apparatus with untiring enthusiasm in the battle against the apparently dead. The „Pulmotor“ spread further to seaside places and coast-guard Stations. Steadily the meshes in the European network of „Pulmotor“ Stations grow narrower, which is spread from the Mediterranean to the highest northern regions and from the Ural Mountains to the Atlantic Ocean. Everywhere care is being taken that the Apparatus can be conveyed in the quickest way to the place of accident, and that the „Pulmotor“ Stations are connected by telephone, in order to facilitate calls being made for the Machine.

Anyone who has been present at a reawakening of an already abandoned victim will readily recognise the blessing of such a rescue service, well organised and ready for action day and night.

The Draeger Company of Pittsburg, a daughter company of the Draegerwerk in Lübeck, has received for the „Pulmotor“ the Scientific American Gold Medal, as being the most effective safety appliance invented during the last few years (compare appendix of this number).

The „Pulmotor“ Organisation has developed in the U.S.A. to an exemplary extent. The Commonwealth Edison Co., The Byllesby Co., the Frick Coke Co., The Sheets & Tube Co., the Rochester Railway & Light Co., and others, put all their „Pulmotors“ spread over all points of their works, gratis at the disposal of the public and private rescue service.

The „Pulmotor“ Organisation of the Rochester Railway & Light Co., have published in all its detail the following instructions:

The following is communicated to all persons interested:

„The „Pulmotor“ is located at our Front Street offices, where it will be at the disposal of physicians and the hospitals for use in cases of emergency. It may be procured by telephoning the Company and notifying the telephone operator where it is wanted and giving name of physician calling. The outfit will be delivered at once by the Company's representatives.“

For the internal service the Company has made the following rules:

- „1 - Get your self ready.
- 2 - Help place Pulmotor, which is in Line Department Office, in Auto.
- 3 - Take two extra oxygen cylinders.
- 4 - Take emergency gas kit.
- 5 - Be sure of address.“

In the garage are the following rules to be observed:

- „1 - When call for „Pulmotor“ comes in from Line Department, either by phone or person, drop everything and at once take out any auto available — a runabout if possible.
- 2 - If no auto is on hand order taxicab from any of the following firms (here follow addresses).
- 3 - Get „Pulmotor“ outfit from Line Department office and man from Gas Shop to operate same.
- 4 - Be sure of address.
- 5 - Stay at scene of accident until released by man in charge.“

NOTE: Calls outside of company will be handled same as company calls.“

Similar „Pulmotor“ Organisation exists in other Companies.

Within the District of the Mining Inspection, Vienna, there has been established through the initiative of the Mining

Authorities and the Permanent Committee for the investigation of fire-damp explosions, a „Pulmotor“ Organisation.

The Imperial Mines Inspection lay special stress in their regulations for collieries on the following:

„The fatiguing work of resuscitation by hand can be promoted by substituting artificial respiration later by automatic artificial respiration with an Oxygen Reviving Apparatus, which, under expert supervision, can be continued for an unlimited period and without trouble.

As such Apparatus, which has proved to be highly efficient not only in cases of gas poisoning, but also in cases of unconsciousness, as well as in cases of drowning, can be recommended the „Pulmotor“ Reviving Apparatus made by the Draegerwerk, Lübeck.

For the correct working of the Apparatus it is of course necessary that the instructions are carefully followed and that the air-ways of the victim are kept open, the same as is the case with the manual first-aid method. The handling of the „Pulmotor“ requires besides a number of manipulations and the observance of many other circumstances, and should be entrusted only to persons well versed with the Apparatus, if there is to be any hope of success.

The „Standing Committee for the investigation of fire-damp explosions“ in Vienna has therefore decided at its meeting on the 25th June 1912, after tests with the Apparatus, that it is desirable to entrust the „Pulmotor“ at every large colliery to the works and mines doctors, who have to see that the Apparatus is always ready for use and in workable condition.

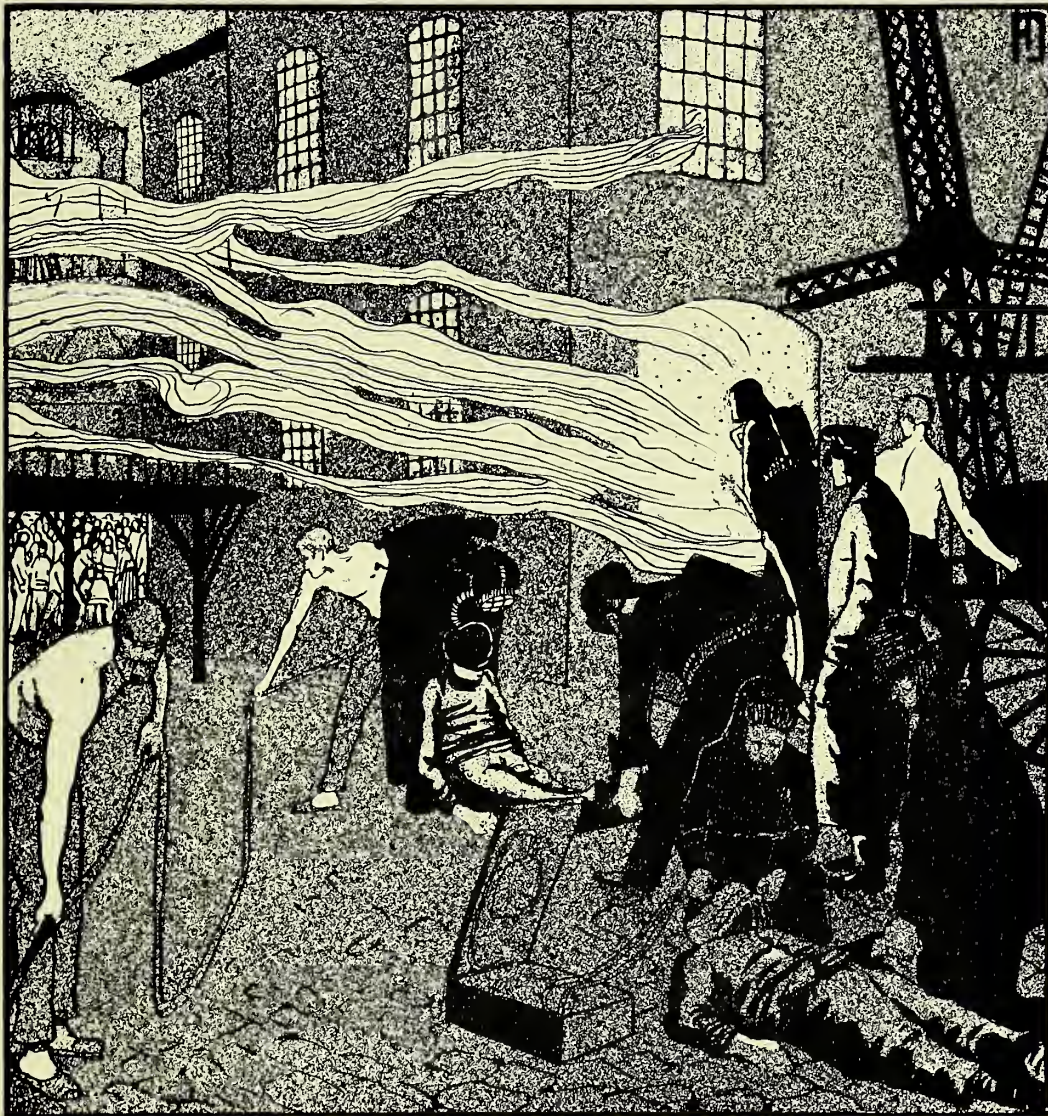
Under reference of § 165 a. B. P. Vrdg. of 5th April, 1897, Z. 459 (§ 147 of a. B. P. V. for Salines), the District Inspection is asked to endeavour to induce every large works and especially collieries to instal the „Pulmotor“ Oxygen Reviving Apparatus for their works and mines doctors, as also for the Central Rescue Stations.

It cannot be surprising that this rescue service, which places the importance of quick firstaid in the foreground, should be accompanied by beneficial consequences.

## II. The Oxygen Trunk.

The „Draeger“ Oxygen Trunk is in its construction the forerunner of the „Pulmotor“. We placed this Apparatus in 1902 on the market. At that time it was only possible in rescue and first-aid practice to support reviving work of persons unconscious, overcome, or drowned, by a troublesome, and in its success doubtful, manual action. Experiments have been made to utilise the life saving properties of Oxygen, but Apparatus, serviceable for this purpose and which employed Oxygen to good effect and were at the same time handy, were missing. On our side we had the important experience, made with our Inhalation Apparatus for hospitals. We had recognised that an easily portable Apparatus should not only reduce the pressure but should also give an adjustable and automatic supply of Oxygen. Our Inhalation Automat fulfilled these conditions. This Automat became the foundation of the „Draeger“ Oxygen Trunk, which is so constructed that it supplies automatically 3 litres per minute. Its oxygen cylinder contains 180 litres of Oxygen, so that the Apparatus works for 60 minutes. The construction of the Trunk is, like the „Pulmotor“, such that it cannot be used in a wrong fashion. Almost 3000 „Draeger“ Oxygen Trunks are at present in the rescue service. They belong to the equipment of numerous Rescue Stations, of mines and factories; to the equipment of Railway first-aid trains; they can be found in Fire Brigades, first-aid corps, first-aid stations and in swimming baths, and have rendered in the wider sphere excellent services.





Rescue Apparatus and  
„Pulmotor“ in Co-  
operation.

*Anny Dräger.*





# The »Draeger« Diving Rescuer for Submarines

by Engineer **Ludwig Claren**. With 3 Illustrations and one Diagram.

The disaster which befel the French Submarine „Pluviôse“ on the 25th May 1910, causing the death of the whole crew, induced the Draegerwerk, who had already then been working for some time on the construction of their Self-contained Diving Apparatus, to place on the market a smaller Self-contained Diving Apparatus — called the „Diving Rescuer“ (Fig. 19).

The „Dräger“ Diving Rescuer is a diving Apparatus with air-regeneration, intended for  $\frac{1}{2}$  hour's sojourn under water or in poisonous gases. The Apparatus can be used under water as well as in gas. The simply constructed Apparatus is mounted on a swimming vest of great buoyancy. The Dress can be donned in a few seconds like a waistcoat, and is stored in the submarine in a small bundle (Fig. 19). The modus operandi of the Apparatus is as follows: (Compare diagram) The expired air flows into the Potash Cartridge where the exhaled Carbon-Dioxide is absorbed. The air, which is now breathable again, collects in the breathing bag after having been previously revived with Oxygen. In a steel bottle is stored the necessary Oxygen. By opening the Valve of the steel Cylinder, the necessary Oxygen is automatically supplied. From the Breathing Bag the regenerated air is reinhaled. Another Valve enables the wearer in moments of greatest activity, in which naturally the Oxygen consumption is larger than normal, to convey Oxygen direct from the store Cylinder into the Breathing Bag. A second bottle containing compressed air may be used to fill the Apparatus in case there should not have been sufficient time to fill the Breathing Bag with outside air, when donned. It is also necessary to dilute the air mixture in the Breathing System and in the Breathing Bag with compressed air, i. e. to minimise the percentage of Oxygen, in case the Diver ascends from depths of more than 20 meters or descends into these depths. On the connecting pipe between the Apparatus and the Breathing Bag, is a Safety Valve, which allows air to escape automatically when the Breathing Bag gets too full, which otherwise would exert a disagreeable pressure on the lungs. This Safety Valve can also be actuated by hand. The Apparatus has been constructed for Mouth-Breathing. The movement of the body is quite free, and the eyes can be protected by diving Goggles.

In case a damaged submarine should be lying in depths below 15 meters, the crew, if there be time and means, should ascend slowly on a knotted rope, which is fixed on the boat (Fig. 18) and stop from time to time in intervals which should be



Fig. 17. Draeger's „Diving Rescuer“  
for Swimming Baths.

haps be permitted to ascend with the Apparatus quickly from depths of about 20 meters. On the water-surface, the diver is no more dependent on the buoyancy of the Breathing Bag. The Apparatus may be put out of action. The Swimming vest alone is able to bear a man with the Apparatus — and above that — for several hours and even for days. Should the Apparatus parts be cumbersome, they can, without previous practice, be detached from the vest. This bears then so much better, especially when the water is rough. The use of the Apparatus is very simple, so that everybody can understand it. Quite a large number of „Draeg by the Navies of several cou

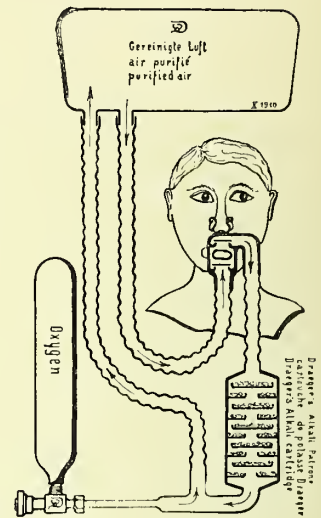
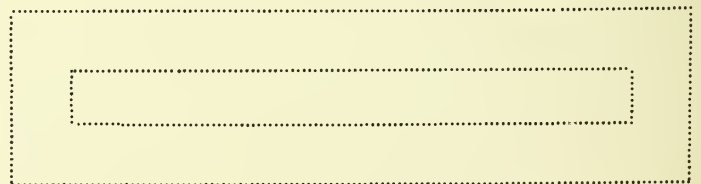


Diagram of the Modus Operandi of Draeger's „Diving Rescuer“.

⑤

Two special types of „Draeger“ Diving Apparatus have been developed from the standard type, namely: the „Diving Rescuer“ for swimming baths, and the „Diving Rescuers“ for hydroplanes. The „Diving Rescuer“ for swimming baths is an Apparatus for diving down and rising up, and enables the wearer to work 30 minutes under water or in high breakers. The whole Apparatus is carried on the back in order to give a great amount of freedom of movement for the arms. Instead of a swimming vest, the Apparatus has been equipped with swimming bags, which can be filled with air at liberty according to the intention of the wearer — to dive down or rise to the surface. All superfluous weight has been avoided. The Apparatus has been constructed for Mouth-Breathing — the head remaining free. The handling of the same is easily to be understood. The second special Type of „Diving Rescuer“ for Hydroplanes is the same in its construction as the 2 types mentioned above. Special attention has been paid in this type to minimise the weight as far as possible. The whole Apparatus is carried on the back, and is mounted on a swimming vest. The equipment enables the fallen flyer to swim and to breathe for 30 minutes under water. The time will be sufficient to enable him to free himself from the shattered hydroplane. The Apparatus has been constructed for Mouth-Breathing. The head and arms remain free, and the handling is very simple.





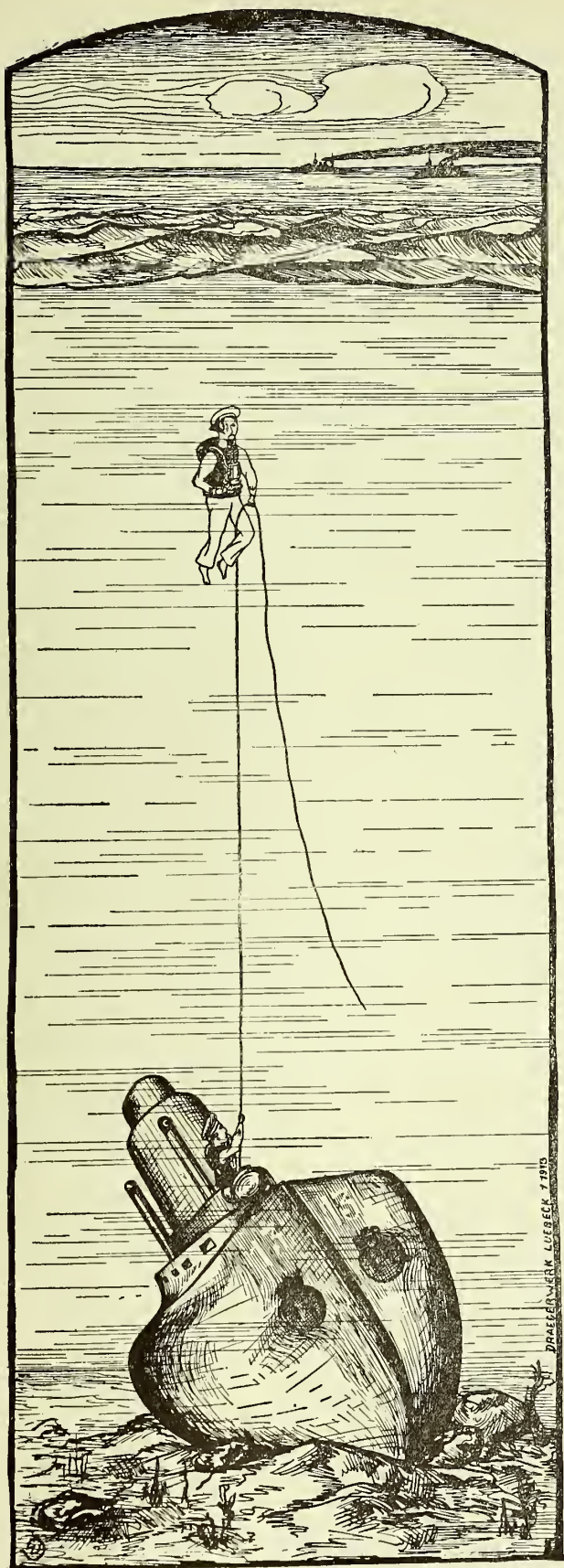


Fig. 18. Leaving a sunken submarine by means of the Draeger „Diving Rescuer“.

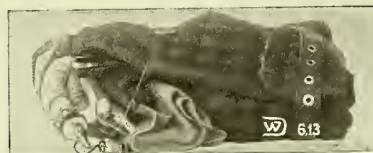


Fig. 19. The Draeger „Diving Rescuer“ bundled up.



Fig. 20. Draeger „Diving Rescuer“ Type DM 1.



# The Self-contained »Draeger« Diving Apparatus

by Engineer Ludwig Claren. With 4 Illustrations.

The self-contained „Draeger“ Diving Apparatus is an appliance for diving in water, introduced principally for work under water of long duration, destined however to render excellent service in salvage and rescue operations. In principle the Diving Apparatus is analogous with the „Draeger“ Rescue Apparatus. The well known experiments of Bernhard Draeger in 1904 which elucidated for the first time correct values regarding the amount of breathing air required and the amount of carbon dioxide produced, have also been fundamental for the construction of the „Draeger“ Diving Apparatus. For the construction of this apparatus, the mechanical working parts of the Rescue Apparatus have been adapted for water pressure.

The „Draeger“ Diving Apparatus makes the diver independent of long and dangerous air-pipes; pump and attendants are also dispensed with.

The equipment consists of a back apparatus in which the air, circulating through the helmet and suit, is automatically purified and revived by oxygen. The diver has 60 to 70 litres of air per minute at his disposal, a quantity which is sufficient for the most strenuous work. The wearer carries on the chest, a weight consisting of steel bottles filled with compressed oxygen or air — (in lieu of the usual lead-weight) — this arrangement serves to regulate the buoyancy. The breathing and regeneration process in the self-contained „Draeger“ Diving Apparatus is as follows: Before closing the window of the helmet, the diver has to take care that the atmospheric air contained in the dress and helmet is not forced out by opening the oxygen cylinder too soon — only after a deep breath has been taken and the window closed, should the cylinder be opened — simultaneously with the opening of the

cylinder valve, the circulation of the air commences within the system — the suit serving the purpose of breathing bags. The expired air is drawn through pipe 1. to the potash cartridge where it is freed of CO<sub>2</sub>, and revived through the injector by oxygen at the rate of 2 litres per minute, and then again conveyed to the mouth and nose of the diver. The circulation continues uninterruptedly and automatically from 2 to 3 hours, according to the work and output, until oxygen and cartridge is exhausted. A watch fitted in the helmet allows the time to be recorded.

The breathing air in Type I of the „Draeger“ Diving Apparatus for 75 ft. depth, is a mixture of oxygen and air, as not the pressure, but the diving work, requires a higher consumption of oxygen. In Type II for 100 feet and in type III for 130 feet depth, equalization, relative to the increasing compression of the circulation air, is permitted by a cylinder of compressed air. The diver is, by means of this reserve, and by manipulating the air valve, in a position, after descending deeper than 75 feet, to let the air mixture escape when it becomes inconvenient, and to take in entirely new air analogous to the atmospheric composition. It can be observed from the Circulation diagram, that only regenerated air can be re-inhaled. The energetic ventilation of the apparatus can be understood by the fact that about 8 500 litres of air circulate through it during two hours work. Professional Divers recognize the freshness of air in the „Draeger“ Diving Suit and praise it accordingly.

Of special importance for the useful application, and as a safety measure, is the telephonic connection with the attendant. The apparatus is fitted with a „sound increaser“ the microphone of which is placed to the side of the mouth, and the receiver opposite the ear. The telephone cable is made strong enough to be utilized as a safety line



Fig. 21. Draeger's Diving Apparatus with Breast-Weight.



Fig. 22. Submarine Sledge for Self-contained Diving-Apparatus.

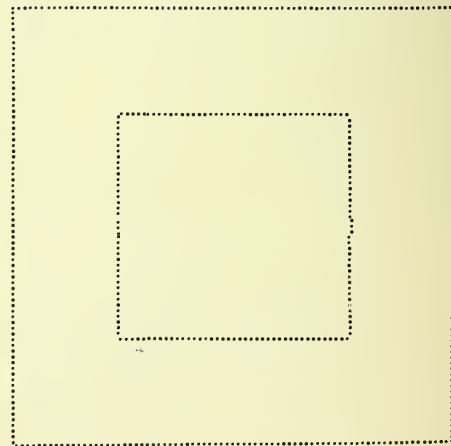






Fig. 23. Divers equipped with self-contained Draeger Diving-Apparatus getting ready to descend.



Fig. 24. Divers equipped with self-contained Draeger Diving-Apparatus rising to the surface.

# „Draeger“ Apparatus for Aeronautics.

With 1 Illustration.

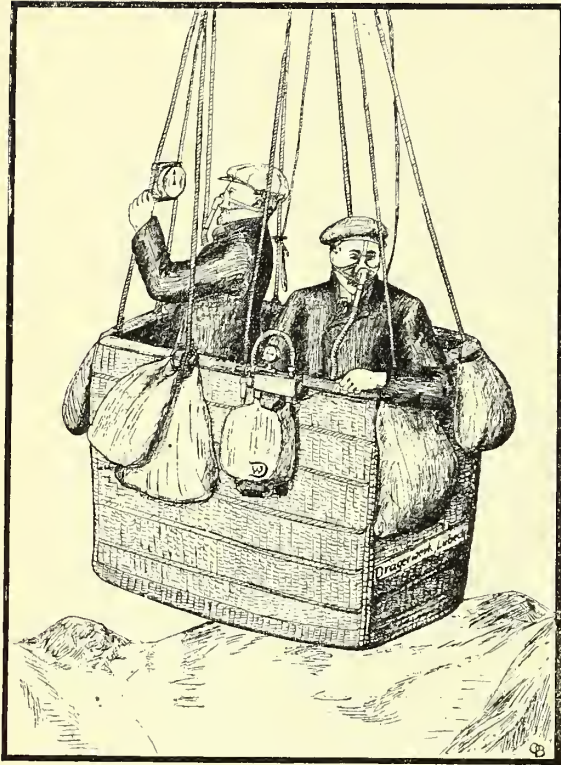


Fig. 25. Draeger's Oxygen Respirator for High Altitudes with Air Regeneration.

Based on valuable works on hygienic of air-navigation by Prof. Dr. von Schroetter, and the eminent Aeronauts, Dr. Fleming, Wigand and others, the Draegerwerk constructed special Breathing Apparatus for this service.

There are two different types; — one for high altitudes in balloons and the other for aero- and hydroplanes. The Works constructed a Respirator, serving as Rescue Apparatus for flying inadvertently at high altitudes, with an Oxygen Store of 180 litres, and another Respirator, for intended high altitude flying, with an Oxygen Store of 2000 litres in large twin steel cylinders. In these Apparatus all the experience gained by long years of successful practice in the construction of Oxygen Inhalation Apparatus are embodied. Special care was also here taken in adapting the Mask for Mouth and Nose Breathing. The Inhalation is started by opening the Valve on the Oxygen Cylinder. A finimeter allows of the control of the pressure contained in the steel cylinders, and the Oxygen consumed per minute can be ascertained from a small manometer. A Regulating Screw on the Reducing Valve permits of an adjustment of the Oxygen supply, from 1 to 10 litres per minute. The Oxygen passes in the first place into an Economiser Bag, and is from thence inhaled through a flexible aluminium pipe, which does not hinder the free movement of the aviator. The additional requirements of outside atmosphere is obtained through a small hole in the Mask, so that the breathing air is as a rule saturated with 40 % of Oxygen, quite sufficient for alveolar tension. The exhaled air and Oxygen surplus escape to the outside. The working capacity of the Apparatus is dependent on the Oxygen consumption. If the emergency type provided with 180 litres of Oxygen consumes on an average 5 litres per minute, the Oxygen Store will be sufficient for 36 minutes breathing. Based on the same average consumption of Oxygen, the type to be used for intended high-altitude flying supplies one Aeronaut with air for 3 to 4 hours — if twin Cylinders are taken up — the same time for two flyers. Special

care should be taken that Breathing Appliances used for aeronautics should be fitted with a Reducing Valve protected against burning out, as otherwise explosions attended by serious consequences may occur. The Draegerwerk has a number of patents for the protection of their Reducing Valves.

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## Autogenous Cutting in the Rescue Service.

With 1 Illustration.

The excellent experience gained in all the metal industries with the autogenous cutting, attracted the attention of such public rescue organisations who oft-times have occasion to rescue persons from iron débris. They had up till then much difficulty in extracting victims from heaps of iron débris such as are to be found in cases of railway catastrophes and the falling in of houses, — the victims in the meantime bleeding to death in sight of rescue workers after long endured pain or of suffocation. Everything calls here for speeding up the rescue and salvage work.

By the adoption of Autogenous cutting in the rescue service of fire brigades and in the international railway ambulance service, it has been possible to cut up masses of entangled iron in a short time, and to move it aside in handy sizes, as also to liberate the survivors quickly from their solid surroundings. It is only a short time since Autogenous Cutting has been adopted for the rescue service, but it is destined to become general for heavy first-aid work.

The process of Autogenous Cutting is based on the fact that metal parts heated by a heating flame up to melting temperature, burn under an Oxygen stream issuing under high pressure, and that the heat developed is sufficient to burn up the adjoining metal parts which again are blown away from the cutting surface by the pressure of the Oxygen jet. For heating, Hydrogen-Oxygen is used, whilst for cutting, Oxygen is applied. Iron of from 2 to 600 millimeters thickness can be worked.

The Apparatus consists of one Reducing Valve for Oxygen, used for heating; one Reducing Valve for Hydrogen; and one Reducing Valve for Oxygen used as cutting agent (figure 27). All „Draeger“ Reducing Valves are constructed to prevent the vulcanite packing being burnt out.

Catalogues and Pamphlets of the Chemical Works Griesheim-Elektron in Frankfurt a. Main, and of the Draegerwerk, Lübeck, give full instructions as to the application of Autogenous cutting; besides these a large amount of literature on this subject is available.





Fig. 26. Draeger Respirator for High Altitude.



Fig. 27. Autogenous Cutting of Steel Plates.

# On the Development of the Draegerwerk

by Engineer Alfred Fröschke. With 3 Illustrations.

Factories should essentially be suitable for the requirements of its produce. It is only too often asserted that is an impossibility to construct such a building aesthetically. There are architects, however, who unconsciously think so, and act accordingly. It has only quite recently been recognised that the usefulness carries with it a high value of beauty, and that in the true shape of the building the character of the material and the character of the works is clearly expressed. Any one standing in front of the high factory building of the Draegerwerk will at once recognise that it has been the aim of the builder to utilise this perception in its exterior and interior construction. As long as the Draegerwerk exists its founders and builders have endeavoured to find the absolute perfect fitness of the factory building; and not in vain. The work as it stands to-day can be considered in all its smallest details as a thoroughly well thought out factory, with due consideration to the welfare of the workmen, the fostering of work and under strict utilisation of floor space and capacity. Its beginning was modest. Up to the year 1897, the development of the building remained in narrow dimensions, but the work of the „Draeger“ Factory already started to develop with safety, although not yet in the domain of the Oxygen industry, which was then in its birth. The third enlargement of the works on the principle of the shed-building, is a proof of this period of development. From the time when Heinr. and Bernh. Draeger — father and son — began to recognise the special qualities of the compressed oxygen, namely: to utilise the pressure which exists in the steel cylinders, a new phase in the development of the works commenced. The Manufacture was directed with the help of applied chemistry and physiology to the creation of new apparatus for use with Oxygen. This was the beginning of the close and fruitful relationship which to-day connect the Draegerwerk with the national rescue organisation and with surgery.

The extension of their manufactures demanded a new extension building; the existing buildings had to be partly demolished and in the year 1908 to be substituted by new buildings. In the following 4 years also these extensions proved to be insufficient. The Management recognised the necessity for drawing up a fixed and permanent building plan for utilising the existing, and by several purchases extended, building site. They recognised that the now unchecked progress of the „Draeger“ produce would force them to a continued enlargement of the factory buildings. On the basis of this farsighted building plan, the fourth extensive enlargement, which, as already mentioned before, abandoned the principle of shed buildings, and arranged the workshops in a 7-floored building, was executed. The development of the factories look, statistically arranged, as follows:

Foundation of works in the year 1888.

1. Extension in the year 1891/2.
2. Extension and new building in the year 1897/8.
3. Extension and new building in the year 1908.
4. Extension and new building in the year 1913.

The latest extension is built entirely of concrete and has a useful floor-space of 3,385 square meters. In the equipment of the workshops, special regard has been paid to lighting, ventilation and suitable flooring, and to other hygienic, and for the workmen comfortable, arrangements. The requirements of the factory authorities have been far exceeded. In all rooms the

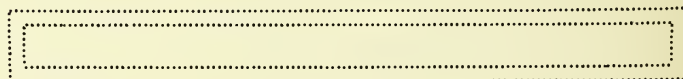
walls and ceilings are white, in order to give a soft light. All the fittings, such as driving gear, clothes- and tool cupboards, shelves, bench supports, wash installations etc. have been painted light as far as is practicable. The arrangement of the windows are such, as to allow of the entrance of plenty of light into all rooms — dark corners and recesses are impossible. Special care has been given to the arrangement of artificial light. This is exclusively electric, and on the average there is one light of 100 candle power for every 4,4 to 5,4 square meters. The heating is effected by means of a low pressure steam system with 3 independent steam boilers (System Strebel=Eca) of each 17,75 square meters heating surface. The heating devices, in the shape of one column radiators, have a total surface of 348,80 square meters, and have been arranged in 175 single groups under the windows. For the two stories under the roof, simpler heating devices are being used. As the windows, by reason of their large surface, would have an intense cooling effect, double glass has been used throughout. In connection with the heating system is a warmwater supply for the workshops and bath-rooms. The floors in the workshops consist of American hard-wood. The electric supply for power and light consists of alternate current of 380 voltage. The tools are driven in groups. 14 motors are provided, and 1 steam engine for the old factory. The motors rest on portable foundations — a new-construction of the Draegerwerk. All the partitions, as for instance for the rooms for the foremen's offices and store rooms, can be yard wise removed, and re-erected if necessary in another place. All stories of the extension building are connected by wide staircases and a large lift (20 h. p. motor). On the top floor of the 32 meters high lift tower, there is a room with a beautiful view on the Town and its pretty surroundings. (Compare illustration on page 135.)

The manufactures extend to-day to the following branches:

**Rescue work:** Oxygen Rescue Apparatus, smoke protecting apparatus for mines and furnaces, fire brigades, gas works, chemical works, for the navy; self-contained diving Apparatus for rescue work; Reviving Apparatus „Pulmotor“ and Oxygen Trunks; Breathing Apparatus for air-ships, stretchers with fresh air hoods; safety lamps; refill Pumps; air-purifying installations for submarines; air-testing and testing apparatus etc.

— **Medical Appliances:** Oxygen Inhalation Apparatus; equipment of Inhalatoriums; Inhalation Apparatus with negative and positive pressure; Oxygen Narcosis Apparatus Prof. Doctor „Roth-Draeger“ and „Prof. Krönig-Draeger“; Operation Apparatus with Positive Pressure, „Prof. Brauer-Draeger“; Medicament Vaporisers Prof. Spiess; Room Vaporisers of different types. — **Technical Apparatus:** Cylinder Valves; Pressure Reducing Valves; Valves for Compressed Oxygen, Hydrogen, air, coal-gas, acetylene and similar gases; Hydrogen Lead Burners; Apparatus for Autogenous Welding and cutting, for Acetylene= and Hydrogen=Oxygen, etc. — **Projection and Photography:** Lime-light burners and projecting Apparatus, photographic art-light installations.


It is characteristic for the Organisation of the Works that all employees of the works are interested in the output by monthly premiums.







### The Draeger Factory with View on Lübeck.

The picture shows the panoramic view spreading before the spectator from the height of the work-tower marked  when looking to the East and North.

To the left in the foreground is shown a wing of the Administrative Building marked 1908.



Typical Draeger Workshop — Fitting the Pulmotors.





The Draeger Works at Lübeck (Germany).





